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Abstract:

Obesity is a global health concern. This is the first study to explore if the relationship between body fatness and time preference is consistent across different ways of objectively measuring body fatness. Our second aim is to explore if there are differential associations between educational attainment and being a saver to determine if education can be used to change saving behaviour and subsequently body fatness. This paper uses data on 15,591 individuals from 2010/2011 of the Understanding Society Survey (UK) to explore the relationship between time preference, measured as being a saver and three objective measures of body fatness: BMI, percent body fatness (PBF), and waist circumference (WC). Our findings show that there is a negative relationship between the three measures of body fatness and being a saver. The strongest relationship is found for WC and being a saver for both genders. Overall, a stronger association is found for women than men. Our results suggest that differential effects by educational attainment can be found in the relationship between being a saver and body fatness. Educational interventions to improve savings behaviour and subsequently obesity may be more effective for women with lower levels of education.

Keywords: UK, BMI, WC, PBF, objective weight measures, time preference, education, multivariate regression

Introduction:

Obesity is a global public health concern. Obesity is associated with increased risk of specific health conditions such as diabetes, coronary heart disease, stroke, some types of cancer, and osteoarthritis. In 2008, approximately 200 million men and 300 million women worldwide were obese (World Health Organisation 2013). In the UK, approximately 25% of the population is classified as obese (NHS Information Centre for Health and Social Care 2013). Obesity is prevalent across all social classes in the UK. However, women from lower socioeconomic groups are at a greater risk of being obese. For men, the relationship between socioeconomic status and obesity is less clear cut (Public Health England 2013).

Time preference is a concept that reflects the degree of impatience of an individual. In the seminal model of the demand for health proposed by Grossman (1972), health behaviours are modelled as investments in health. Choices regarding how much to invest in health can be thought of as being made to maximise expected discounted utility over the lifetime. Individuals with a higher time preference rate (i.e. those who are more impatient) may be less likely to invest in activities with low levels of instant gratification such as exercise and healthy eating that help to promote a healthy weight.

Fuchs (2004) suggested that factors related to socio-economic status, such as education, may be correlated with time preference. Individuals with lower rates of time preference may be more likely to stay in school or, alternatively, it is possible that additional years of schooling lower time preference rates. Following on from this, those with higher time preference rates may be in lower socioeconomic groups and choose to invest less in health leading to worse health outcomes. This may partially explain health inequalities.

This paper has two main aims. Firstly, to explore if the relationship between time preference and body fatness is consistent across three objective measures of body fatness: Body Mass

Index (BMI), waist circumference (WC), and Percent Body Fatness (PBF). Using objective measures of body fatness eliminates all of the biases caused by self-reported measures. There is some evidence that BMI may not be an accurate measure of body fatness (Burkhauser and Cawley 2008) as it does not separate fat from fat free mass. WC and PBF are more accurate representations of the health risks associated with excess weight (Prentice and Jebb 2001; Ashwell et al. 2012).

The second aim is to explore differential effects on the relationship between educational attainment, savings, and the three body fatness measures. If the relationship between education and savings is not consistent across different levels of educational attainment, interventions related to education may alter time preference, measured by the savings rate, and subsequently body fatness. According to Lusardi and Mitchell (2014) both general knowledge (education) and more specialised knowledge (financial literacy) contribute to better financial decision-making strategies that result in higher savings, our proxy. If general education and financial education impact on individual perceptions of the future, this may also change behaviour related to investments in future health and subsequently health outcomes such as body fatness. A potential association between time preferences and health, particularly strong for specific socioeconomic groups, may be a significant contributing factor to health inequalities (Guthrie et al., 2009). In the UK, such inequalities continue to widen (Marmot, 2010), even in the presence of a well-established welfare state, universal access to free health care and advances in public health practice. Holistic public health policies aiming to modify more general behaviours, not directly linked to health, might be needed to tackle the well documented socioeconomic obesity inequalities (Zaninotto et al. 2009; Zhu et al. 2015). If there are differential effects across educational levels on the relationship between education and savings on body fatness outcomes, this may be one target area that has been overlooked in most public health obesity interventions.

Background:

Time Preference and Socioeconomic Status:

There have been a number of studies finding a positive relationship between future orientation and socio-economic status (Lamm et al. 1976; Fuchs 1982; Guthrie et al. 2009). Recent work by Golsteyn et al. (2014) used Swedish longitudinal data where time preference was measured through a questionnaire given to children aged 13 that asked to what extent respondents would prefer $138 USD (900 SEK) today to $1380 USD (9000 SEK) in five years' time. They explore how these time preferences responses are associated with educational choices, fertility choices, health, labour market outcomes, and lifetime income over five decades. Results show that higher time preference rates were associated with lower levels of labour supply and lower household income. Fuchs (2004) and Grossman (2006) suggest that educational attainment may be related to time preference and can possibly explain some of the returns to education in terms of higher wages and occupational attainment. A causal pathway between time preference and socio-economic status, measured as educational attainment, has not been established. Thus, it is not clear if more education would improve time preference rates and subsequently health outcomes. In this paper, we explore if there are differential slopes on being a saver by educational attainment level. This would provide evidence to support educational interventions to change individual's savings behaviour and subsequently health outcomes.

Time Preference and Body Fatness:

There is a growing body of work exploring the relationship between time preference and body fatness. Komlos et al. (2004) use longitudinal data from the US and international cross-sectional data to explore if it is plausible to make a link between obesity and time preference. They find that lower savings rates and greater debt are associated with a higher time preference rate. This may explain the rising obesity rates from the 1970s, as in the US debt has been rising and savings have been falling. Smith et al. (2005) explore the hypothesis that higher time preference rates are associated with a higher BMI using the National Longitudinal Study of Youth (NLSY). As a proxy for time preference they use data from 1989, when the average respondent was 28, asking if they had put more money in savings than they had withdrawn (saver), had withdrawn more than they saved (dissaved), or if their savings had remained constant over the previous year. They find that when aggregating across ethnicity, higher time preference rates are positively associated with BMI for men with this effect being less strong for women. If the results are disaggregated by ethnicity, a higher time preference rate is positively associated with BMI for black and Hispanic men and black women. Courtemanche et al. (2014), also use the NLSY, but utilise different questions relating to time preference from the 2006 survey on intertemporal trade-offs to estimate a discount rate which is matched with price data from the Cost of Living Index. They find that time preference is positively associated with BMI, the likelihood of being overweight, and obesity. The effect is largest for white males.

The psychological literature has traditionally used the term ‘time perspective’ which is similar to time preference in that both relate to delayed gratification. However, time perspective takes a more holistic approach, including how individuals orientate themselves towards and think about the future (Adams and Nettle 2009). Adams and Nettle (2009) use data collected from a community internet message board in urban US (n=423). To proxy for time perspective, a delayed discount rate, Consideration of Future Consequences Scale (CFCS), Zimbardo Time Perspective Inventory, subjective probability of living until 75, and time period for financial planning were utilised. Results found that future oriented time perspective measured only using the CFCS was positively associated with a lower BMI.

Griva et al. (2014) utilise a web-based questionnaire on Greek population (n=413) where time perspective is measured using a short version of the Zimbardo Time Perspective Inventory, which consists of 21 items measuring five dimensions (positive attitude towards the past, negative attitude towards the past, present hedonistic, present fatalistic, and future orientated) on a five point Likert Scale (Griva et al. 2013). They found that being more present orientated was associated with a higher BMI. Whereas, Guthrie et al. (2013) use data from a cross-section of patrons to barber shops and hair salons in the Washington DC area (n=525) and three dimensions of the Zimbardo Time Perspective Inventory (present hedonistic, present fatalistic, and future orientated) and impute mean data for missing data on any dimension (n=63). Results show that time perspective was not significantly associated with obesity. These studies focus on different populations and use different proxies for time perspective which may partially explain the mixed results.

These findings suggest that time preference rates may be a contributing factor to obesity outcomes. What is unclear from these results is what pathways may explain this relationship. Additional information on these pathways will help to design interventions aiming to modify the savings rate, our time preference proxy.

Weakness of BMI as a Measure of Body Fatness

Burkhauser and Cawley (2008) discuss the short comings of relying on BMI as a measure of body fatness as it does not distinguish body fat from fat free mass such as muscle and bone. Thus, BMI can incorrectly classify some individuals such as athletes as overweight or obese. Additionally, evidence from the medical literature suggests that the location of body fatness is important. Visceral body fat stored in the abdominal cavity around the internal organs is associated with elevated risk for obesity related health conditions (Montague and O'Rahilli 2000; Klein et al. 2007). PBF and, to a lesser extent, WC (Klein et al. 2007) capture this type of body fatness more accurately, which has a stronger association with obesity related health risks.

Burkhauser and Cawley (2008) find that the relationship between employment and obesity is sensitive to how obesity is measured. It is possible that the relationship between time preference and body fatness may also be sensitive to the measure used. This would have implications on how evidence on this correlation can be used for policy-making and progressing this research area forward.

Because of the limitations of the secondary datasets used for analysis, all research on time preference and body fatness has relied on BMI. We will use a novel dataset, Understanding Society (US), which includes BMI but also other objective measures of body fatness such as WC and PBF via bioelectrical impedance which separates fat free mass from fat mass. Therefore, we can compare our results, as well as results from the previous literature using BMI, to alternative measures of body fatness to determine if the same relationship with time preference holds. Objective measures of body fatness mean that we will not have self-reported bias. Helping to establish if there is a significant association between time preference and body fatness and will aid future analysis to establish a causal relationship.

Data:

This paper uses cross-sectional data from Wave 2 (2010/2011) from the US survey (UK) (University of Essex 2013). The analysis is limited to wave 2 because this is the only year that contained information on proxies for time preference and objective measures of body fatness. The first wave of the US survey was collected in 2009. US is an annual longitudinal household survey of approximately 40,000 households.. All adults in each household are asked about their personal background, finances, employment, expectations and aspirations, friends and family, health and happiness, neighbourhood, time use, and leisure. In Wave 2 a sub-set of 20,000 households were invited to take part in a follow-up health assessment by a registered nurse who asked additional health questions and took a range of physical measurements, including height, weight, WC, and PBF via bioelectrical impedance. (University of Essex 2013). The nurse assessment sample was chosen based upon a random selection of 0.81 households in the primary sampling unit to ensure that the data remained nationally representative. From the 26,691 individuals deemed eligible for the nurse assessment 58.6% completed the survey (n=15,591). This study employs anonymised secondary data that does not require ethical approval for its use.

Dependent Variables:

This analysis will use as dependent variables three objective measures for body fatness taken from the health assessment sub-set questionnaire. These are: 1) BMI; 2) WC; and 3) PBF.

For all body fatness measures, individuals that were pregnant (n=144), physically (such as having a pace maker, a colostomy or ileostomy) or mentally unable to have measurements taken (n=77) were excluded from the analysis.

BMI was calculated using nurse measured height and weight. All measurements were taken without shoes or socks, with feet flat on the surface. Height was measured using a portable stadiometer, consisting of a footplate, measure rule and an adjustable head plate. A head alignment check was performed using a card in the Frankfort plane to increase the accuracy of the measurement. Weight was measured using a digital floor scale, the Tanita BF 522 scales to the nearest .1kg. The scales were not accurate for weight over 130kg so an estimated weight was used for these individuals (n=21). BMI was calculated as weight in kg divided by height in metres squared, using non-missing pairs of height and weight where no measurement problems were recorded and with weight substituted with the estimated weight for participants weighing 130kg or more.

PBF of individuals was estimated by bio-impedance analysis, using the Tanita BF 522 scales. The body type for all participants was set to “Standard”, as it required less training for the nurses taking the measurement and standardises all measurements.

WC was measured using a tape with an insertion buckle at one end. The location of the measurement was defined as the midpoint between the lower rib and the upper margin of the iliac crest. Measurements for each individual were taken twice and were recorded to the nearest millimetre. If the two waist measurements differed by more than 3 cm, a third measurement was taken.

More information on how the body fatness measures were taken can be found in McFall et al. (2013). Figures 1 to 3 show the raw correlation in the three body fatness measures. We find a strong correlation between all three measures. Thus, we feel confident that we can compare the results across the three different body fatness measures. For women in Figures 1-3 there is a linear relationship between the three measures. For men in Figures 1 and 3 there is a curvilinear relationship at the higher end of the BMI and WC scale respectively. Previous research has found mixed results when exploring the correlation between BMI and PBF. Ranasinghe et al. (2013) found a strong correlation between the two, whereas Meuwseen et al. (2010) found a weaker correlation. A number of studies (Gierach et al. 2014; Helala et al. 2014; Janssen et al. 2002) found waist circumference and BMI to be strongly correlated. Flegal et al. (2009) found PBF to be more strongly correlated with WC than BMI in men and PBF to be more strongly correlated with BMI than WC in women.

The distributions of BMI, PBF, and WC by gender are displayed in Figure 4. All three body fatness measures are roughly normally distributed for both men and women. However, there are slight differences between men and women. The distributions for BMI in Figure 4A and WC in Figure 4C are slightly more skewed to the right for women than for men. The opposite can be observed for PBF in Figure 4B.

Key Explanatory Variables:

Time Preference:

Time preferences cannot usually be directly observed in non-experimental studies. Thus, much of the empirical literature relies on proxies, usually related to financial savings behaviour (for example, Picone et al. 2004, Khwaja et al. 2007, Samwick 1998).

In the literature exploring the association between BMI and time preference a number of financial proxies have been used. Borghans and Golsteyn (2006) using Dutch Data from the DNB survey test the association of a number of proxies for time preference with BMI. They find a significant association between the ability to manage expenditures and BMI. Specifically variables related to controlling expenditure and managing household finances have the strongest association. This association holds after controlling for education. Komlos et al. (2004) and Smith et al. (2005) use the savings rate as a proxy for time preference. Smith et al. (2005) hypothesise that those with a lower time preference rate are more likely to report savings than those with a higher time preference rate who are more likely to spend their income.

Following on from previous literature and partially as a matter of convenience given the data we have available, we utilise the savings rate as a proxy for time preference. Specifically, we utilise:

"Do you save any amount of your income, for example by putting something away now and then in a bank, building society, or Post Office Account, other than to meet regular bills? Please include share purchase schemes, ISAs, and Tessa accounts."

Options available to respond were 'yes' or 'no'. This variable was used because it was asked to all respondents. Variables related to amount of savings on a monthly basis, if individuals saved regularly or occasionally, and if they saved for the short or long term were only asked to respondents that reported yes to saving any amount. Thus, these variables would not be informative for our analysis as they would only be reported for individuals that consider themselves to be savers.

In the raw data we find a negative and significant correlation between BMI and savings for men -0.04 (p=0.004) and women -0.07 (p=0.000). A negative and significant correlation is also found for WC and savings for men -0.04 (p=0.0001) and women -0.08 (p=0.000). There is also a negative and significant correlation between PBF and savings -0.03 (p=0.01) for men and women -0.04 (p=0.001). In the econometric model we explore this association further.

Socioeconomic Status:

Socio-economic status will be measured using income (equivalised household income and individual labour income), and education (university degree or postgraduate qualification, A-level or equivalent (some higher education), GCSE or equivalent (high school diploma level), and no formal qualifications) (Rose and Harrison 2007). Employment status is also included as a control variable in the analysis.

Additional Explanatory Variables:

Regional indicator variables are also included in all model specifications. Regional differences exist in both obesity and socio-economic status in the UK (Ellis and Fry 2010). We exclude Northern Ireland in the analysis to focus on mainland UK only.

The descriptive statistics for the sample are shown in Table 1. The mean BMI for both men and women is in the overweight range. This is consistent with data from other nationally representative samples. The Health Survey of England (HSE) 2013 found approximately 67.1% of men and 57.2% of women were overweight (Craig and Mindell 2013). The mean w WC for men is 99.43 cm and for women it is 89.29 cm. Data from 2009 from the HSE found that mean WC for women was 87 cm and was 96 cm for men which is slightly lower than what we found in our data, but our data also includes Scotland and Wales which may explain these differences. The mean PBF for men is 23.58% and the mean PBF for women is 36.29%. There is no other national level data to compare PBF with.

Approximately 45% of men and 42% of women report having savings. The mean age of the sample is 51 for men and 50 for women. Just over half the sample is employed.

Econometric Framework:

Using Ordinary Least Squares Regression, we start with a basic model of our three body fatness outcomes as a function of age, region, and our time preference proxy, savings. The next step is to add in other variables in the model which can be considered decision variables. This will show the partial effect of our time preference proxy after controlling for other variables that may also be proxies for time preference, such as educational attainment, or be correlated with our time preference proxy such as household income, employment status, marital status, and number of dependent children under the age of 16. This will allow us to determine if being a saver is still significantly associated with body fatness. If this is the case, we can argue that being a saver is a valid proxy.

To explore potential avenues for developing interventions to reduce obesity rates, we estimate models with interaction terms for educational attainment and savings. All models are estimated separately with an interaction term for savings and each educational attainment level. If the slope of the savings variable is significantly different by level of educational attainment this may provide support for developing educational interventions to alter individual saving behaviour and, subsequently, their health outcomes.

Results:

Base Model:

The results from the base model are presented in Table 2. All measures of body fatness for both men and women are significantly and negatively associated with being a saver. The magnitude of the savings coefficients are larger for women than men. Pooled models are estimated to determine if the savings coefficient is significantly different between men and women. Wald tests show that the savings coefficients for all three measures of body fatness are significantly different between men and women. Female savers are likely to have a BMI that is approximately 1kg/m^2 lower than a non-saver, a WC that is 3cm lower than a non-saver and a PBF approximately 1% lower than a non-saver. As can be seen in Figure 1-3, the three measures of body fatness appear to be correlated. Thus, we also estimate seemingly unrelated regression models to determine if the magnitude of the coefficients between the three body fatness measures are statistically significantly different assuming the dependent variables are correlated. For men, post-estimation Wald tests show that there is a statistically significant difference in the coefficient size of the savings variable for WC and BMI. Whereas for women, the post-estimation Wald test shows that there is a statistically significant difference in the coefficient size of the savings variable between PBF and WC, and WC and BMI. This suggests that differences exist in the magnitude of the relationship between savings and the three body fatness measures. The largest association between savings and body fatness for both genders is found for WC.

For men, our results for objectively measured BMI (-0.560) are similar to those found in the literature using self-reported BMI. Smith et al. (2005) found a significant and positive relationship of (0.594) for men who spent more than they saved and (0.529) for men whose spending equalled their savings with BMI. However, for women, the results are different to those of Smith et al. (2005). They found that the relationship between spending over one's earnings and BMI was insignificant (0.461). It is possible that there are cross-country differences in the relationship between the savings rate and body fatness for women. Additionally, the use of objective measures may be more important for accurately assessing the relationship between savings and body fatness if reporting bias between savings and BMI are correlated for women biasing the coefficients.

The other coefficients in the model have the expected signs. There is a concave relationship between age and the three body fatness measures which is consistent with other studies (Kifle and Desta 2012). Compared to those living in London, both men and women in the North East and West Midlands have significantly higher body fatness for all three measures. Living in the South East, East of England, East Midlands, and Wales is significantly associated for men with having higher body fatness for all three measures compared to men in London. Living in Scotland and the North West is positively and significantly associated with all three measures of body fatness for women compared to women living in London. For other regions, a significant and positive association is only found for some body fatness measures such as PBF for men in the South West.

Partial Effects:

The results from the models including variables on individual decisions that may also proxy for time preference can be found in Table 3. As expected, the magnitude of the savings coefficients is smaller than in Table 2. The decrease in the savings coefficient was 26% for BMI, 30% for WC, and 36% for PBF for men. For women, the percent decrease was 40% for both BMI and WC, and 35% for PBF. The relationship is still highly significant suggesting that savings may be an adequate proxy after controlling for education, income, and marital status which are likely to be correlated with our proxy for time preference. Consistent with the literature (see, for example, Hermann et al. 2011), being educated to the degree level is significantly and negatively associated with all three measures of body fatness when compared to individuals with no qualifications for both sexes. For women, being educated to any level (GCSE, A-level and degree level) is statistically significantly associated with at least two body fatness measures, the only statistically significant association between education and body fatness for men can be observed at degree level. Moreover, for men, a positive but insignificant association is found between being educated at GCSE level and BMI and WC. This is surprising and suggests a stronger negative association between education and body fatness for women compared to men. For women only, compared to non-participating in the labour market, being both employed and unemployed was significantly associated with a lower BMI. For employed women, a negative and significant association was also found for WC compared to those that were not in the labour market. For women only, increasing household income was negatively and significantly associated with all three body fatness measures. These results are consistent with the relationship between obesity and socioeconomic status being stronger for women than for men (Public Health England 2013).

Interaction Effects:

The results from the interaction effects of education and savings are found in Table 4. First looking at the top half of the table for men, we can see across the different model specifications, that there is a negative and significant association between being educated to the degree level and the three measures of body fatness. This is consistent with the results in Table 3. With the exception of column (7) and column (8), there is a significant negative association between being a saver and body fatness. A significant interaction term is only found for being educated to the GCSE level and savings. For those educated to the GCSE level, savers compared to non-savers have on average a higher PBF. For women, in the lower half of Table 4, we find significant and negative associations for both being educated to the degree level, or higher, and being a saver across all model specifications. In columns (1) and (3) and across all WC models, a negative and significant association is found with being educated to the degree level. Additionally, for women, a negative and significant association between being educated to the GCSE level and BMI and WC is found in columns (1), (2), (4) and (5). A marginally positive interaction effect between degree level education and being a saver on WC is found in column (4). A negative and significant coefficient is found on the interaction term for being educated to A-level and being a saver for both BMI and WC. These results imply that encouraging women to reach higher education levels as well as participating in other more specific financial education interventions targeted to this particular group might contribute to reduce female obesity.

Discussion and Conclusion:

This paper examined the correlation between time preference, measured by being a saver, and three objective measures of body fatness: BMI, WC, and PBF. Overall, we find a consistent negative and significant relationship between being a saver, compared to not saving, and the three measures of body fatness. The coefficient size is statistically significantly different for women when comparing PBF and WC and WC and BMI, and for men when comparing WC and BMI. The largest coefficient size for both genders is found for the association between WC and savings. Interventions targeting savings behaviour may have a larger impact on WC. The medical literature (Montague and O'Rahilli 2000, Klein et al. 2007, Ashwell et al. 2012) finds that visceral body fatness has a stronger association with obesity related morbidity; this implies that previous studies which have focused on the relationship between self-reported BMI and savings may have underestimated this relationship. Our results using objectively measured BMI for men are largely consistent with the literature that uses self-reported measures (Smith et al. 2005, Adams and Nettle 2009, Courtemanche et al. 2014). A higher BMI is associated with being more present orientated. However, our results for women contradict what has been found in other studies (Smith et al. 2005, Courtemanche et al. 2014). We find a stronger association for women than men across all three objectively measured body fatness indicators. Previous work for women, using self-reported measures of BMI underestimated the importance of the relationship between savings and BMI. This has implications for the development of future interventions and policy.

The second aim of this paper is to explore potential avenues which could be used to develop innovative obesity interventions. Specifically, we look at if there are differential effects by educational attainment on the relationship between being a saver and the three measures of body fatness. The financial capability literature suggests that both additional years of schooling as well as financial education are effective ways of improving the savings rates of the population (Lusardi and Mitchell 2014). Differential effects by educational level suggest that education interventions could influence savings behaviour and subsequently body fatness. We find that this type of interventions may be more effective for women with moderate levels of educational attainment. A consistent effect is not found across the three body fatness measures. Thus, policy makers should be clear on what body fatness measure they want to focus on, what the health benefits may be, and how this may differ if at all from using another measure of body fatness.

A limitation to this study is that we only have one proxy for time preference. Borghans and Golsteyn (2006) show that not all time preference proxies are correlated with BMI. Additional proxies would have enabled a more robust study. We also use cross-sectional data so we cannot explore if this relationship holds over time. Because of the relevance of these findings to inform public health policy, future research should explore if future orientated individuals are more likely to lose weight and keep off this weight.

This study can contribute to the design of public health policies in two major ways. First, this research highlights the importance of how body fatness is measured and that using objective measures makes a difference, which is crucial to inform policy design. Secondly, our findings suggest that an association exists between savings and better weight management, particularly for women. Socioeconomic factors are also only significant for women and may help to explain persistent health inequalities. Recent educational interventions such as the introduction of financial literacy in the National Curriculum in the UK might not only be effective in increasing savings and gradually raising subsequent asset accumulation in adulthood (Bernheim et al. 2001), but also in reducing obesity levels and longer-term inequalities. At the same time, because women generally experience larger gaps in their financial knowledge compared to men , tailoring financial education programmes for women with moderate levels of education might not only improve their likelihood of savings (Lusardi and Mitchell 2014) but also obesity rates.

Our results support the idea that there is a need for more holistic and indirect public health initiatives that attempt to ‘influence behaviour’, whilst accounting for people’s social environments, if health inequalities are to be successfully tackled. A negative and significant interactive effect for women with lower education levels suggests that education policy particularly targeted at women on the lower end of the socioeconomic spectrum, may be effective at reducing health inequalities.

The relationship between time preferences and health outcomes needs to be better understood to reduce health inequalities. Time preferences might be acting as a potential underlying mechanism and awareness of this is key for policy design and implementation.

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Figure 1: *The relationship between BMI and PBF*

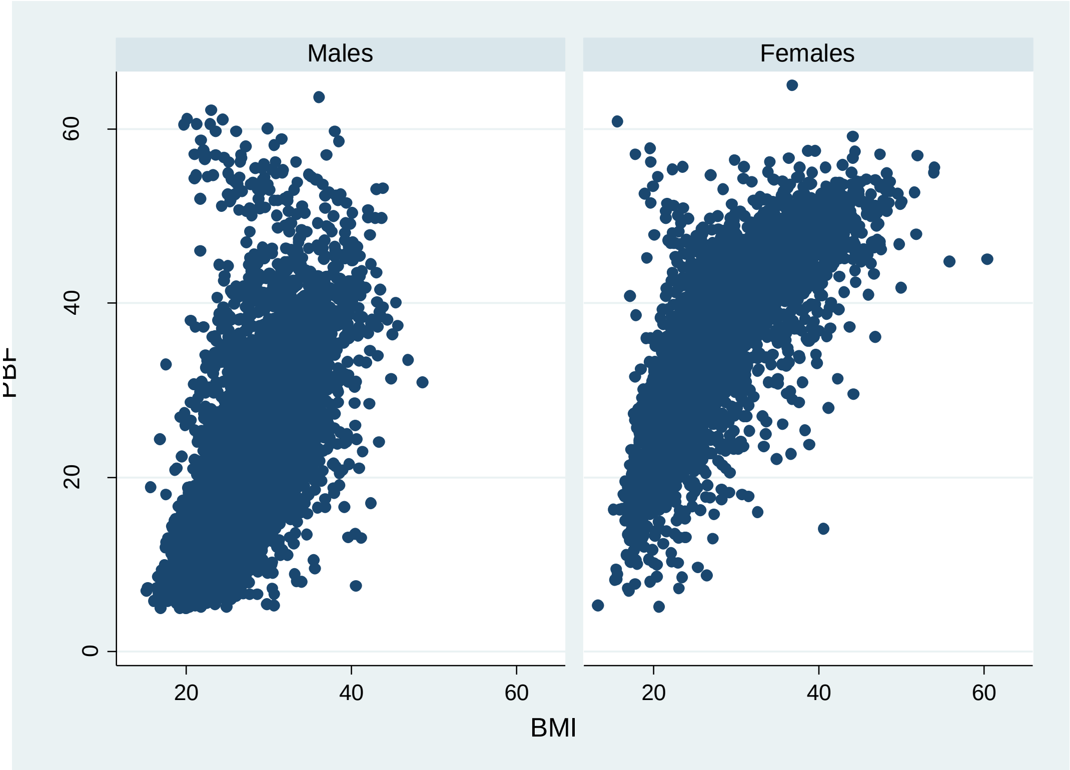


Figure 2: *The relationship between BMI and waist circumference*

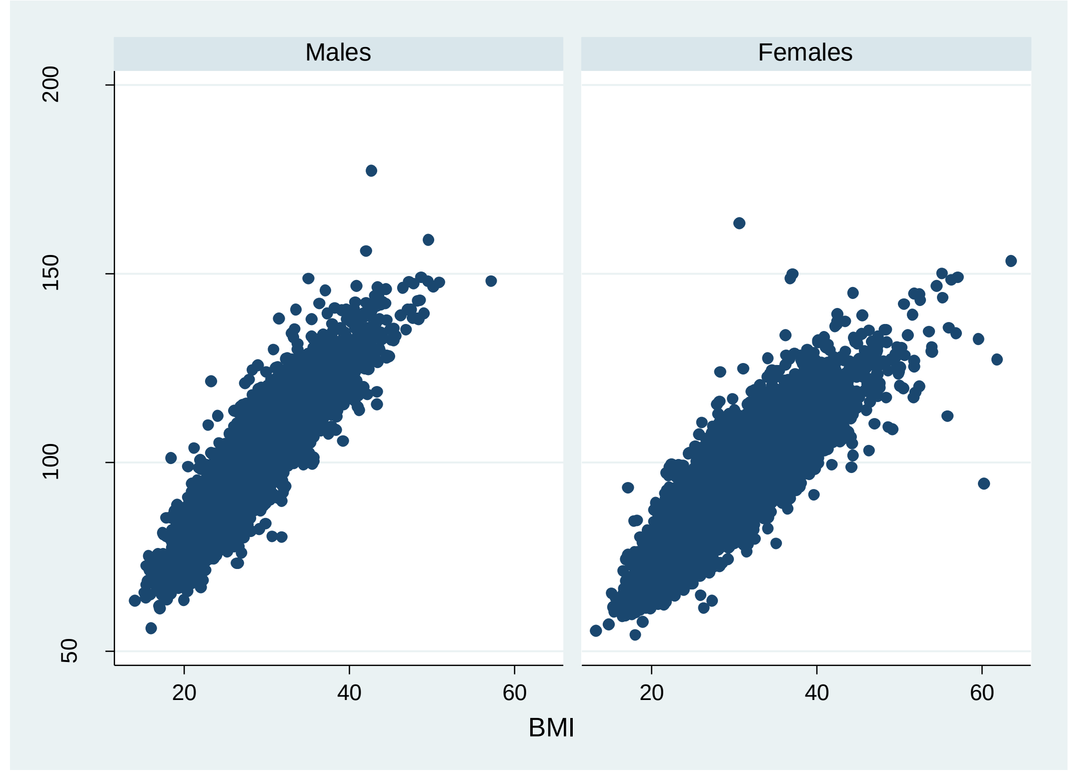


Figure 3: *The relationship between waist circumference and PBF*

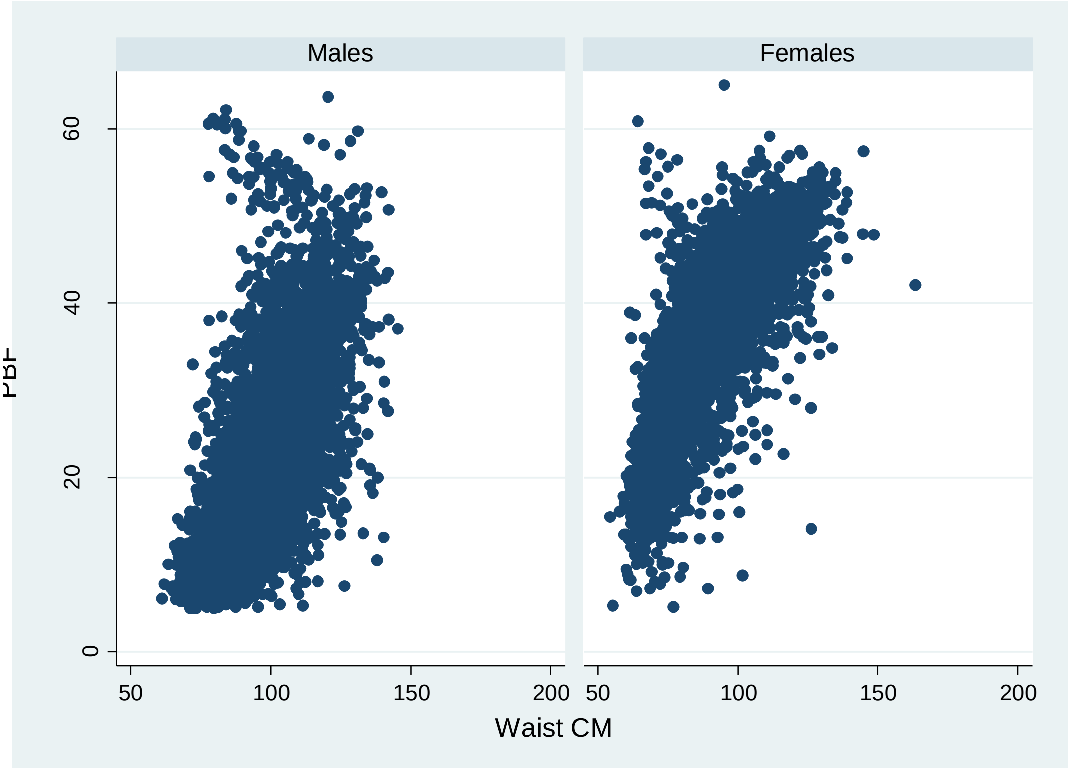
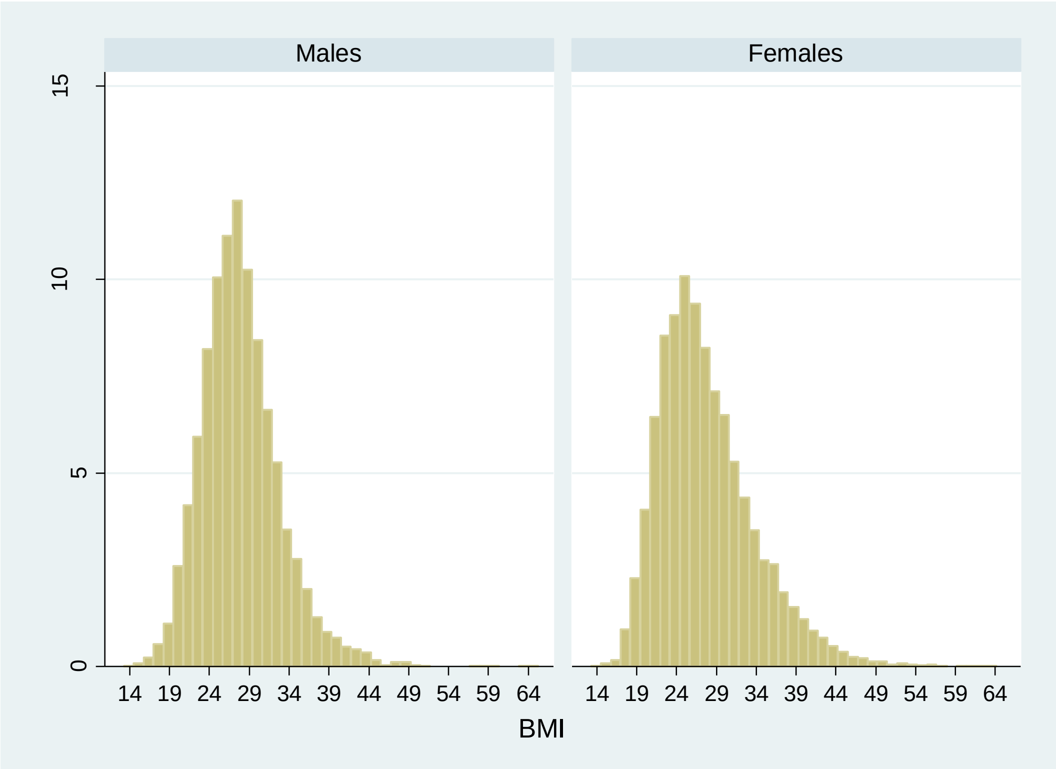
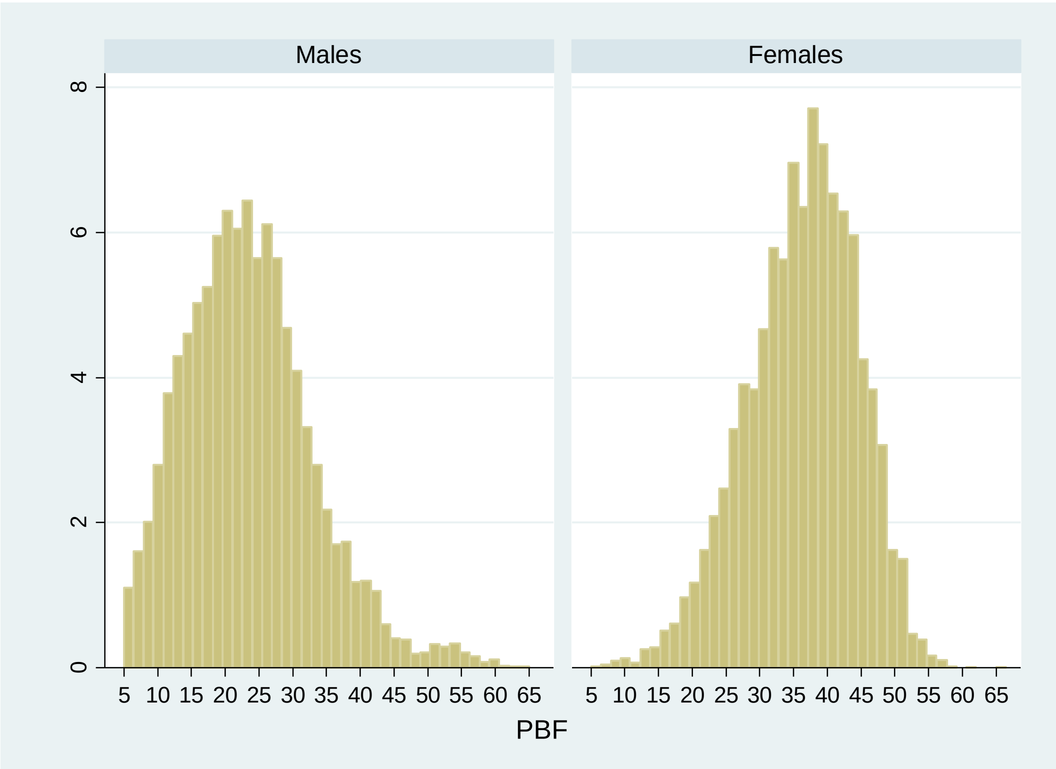


Figure 4: *Distribution of BMI, WC, and PBF by gender*

A. BMI



B. PBF



C. WC

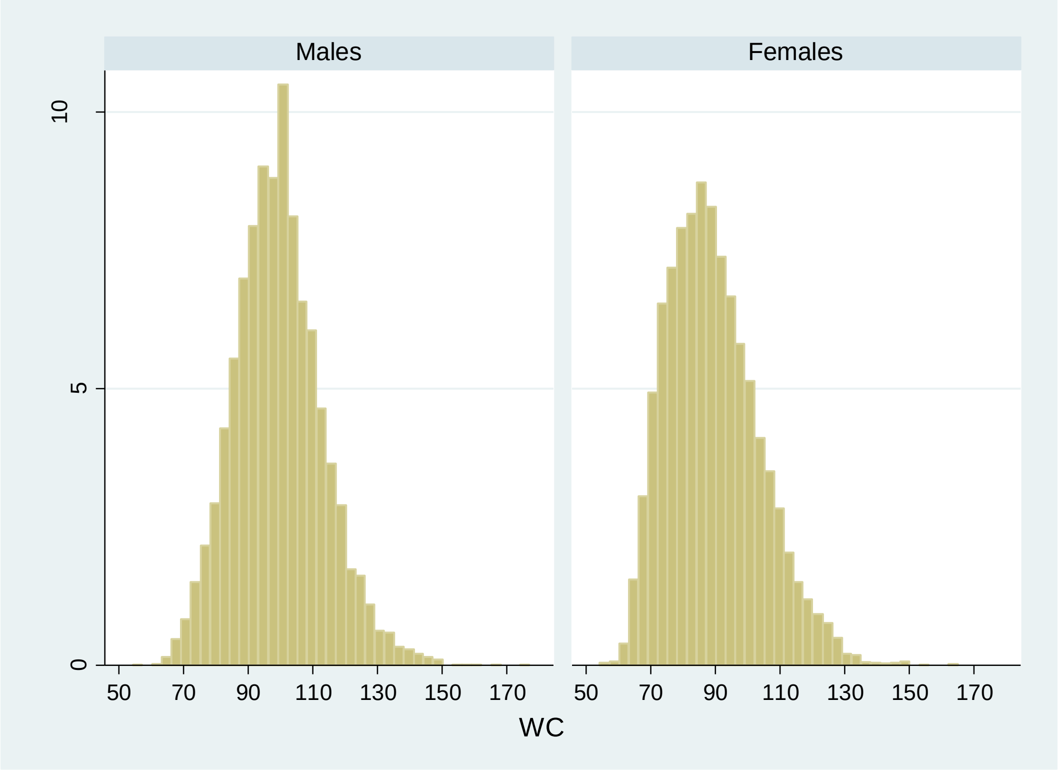


Table 1: *Descriptive Statistics*

	Males	n	Females	n
BMI	27.98 (4.95)	6558	27.85 (6.03)	8466
WC	99.43 (13.67)	6722	89.29 (14.24)	8617
PBF	23.58 (9.62)	6149	36.29 (8.18)	8137
Saver	0.45 (0.50)	6826	0.42 (0.49)	8772
Age	51.35 (17.98)	6843	49.79 (17.70)	8789
Married	0.62 (0.49)	6505	0.57(0.49)	7927
Divorced/separated	0.11 (0.31)	6505	0.17 (0.37)	7927
Degree	0.37 (0.48)	6424	0.37 (0.48)	8198
Associate	0.23 (0.42)	6424	0.17 (0.37)	8198
High school	0.19 (0.39)	6424	0.23 (0.42)	8198
Employed	0.56 (0.50)	6843	0.50 (0.50)	8789
Unemployed	0.05 (0.23)	6843	0.04 (0.19)	8789
Children under 16	0.02 (0.15)	6843	0.51 (0.91)	8789
North East	0.05	370	0.06	512
North West	0.13	867	0.13	1124
Yorkshire & Humberside	0.10	656	0.09	830
East Midlands	0.09	631	0.09	801
West Midlands	0.10	658	0.09	806
East Of England	0.12	795	0.11	952
South East	0.16	1069	0.16	1377
South West	0.11	745	0.11	986
Wales	0.03	190	0.03	254
Scotland	0.05	311	0.05	414
Equivalised household income	17926.43 (14934.55)	6835	16713.39 (13631.24)	8780

Notes: Standard deviations are in parentheses. BMI is measured by kg/m^2. WC is measured in centimetres. PBF is a measure of percent body fatness. Age is measured in years and equivalised household income is measured in GBP in 2010/11 levels. The remainder of the variables are percentages. Base category for saver variable is does not save regularly. Base category for marital status variables is single. Base category for education variables is no educational qualifications. Base category for employment variables is not in the labour force. Base category for children variable is no children under the age of 16 in the household. Base category for region variable is London.

Table 2: *Base model - Relationship between savings and body fatness*

	Men			Women		
	(1M)	(2M)	(3M)	(1W)	(2W)	(3W)
VARIABLES	BMI	WC	PBF	BMI	WC	PBF
Age	0.437***	1.295***	0.617***	0.293***	0.727***	0.440***
	(0.031)	(0.080)	(0.059)	(0.034)	(0.076)	(0.045)
Age squared	-0.004***	-0.011***	-0.005***	-0.003***	-0.005***	-0.003***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
North East	0.995***	1.762*	3.178***	1.254***	1.891**	2.157***
	(0.374)	(0.963)	(0.712)	(0.391)	(0.885)	(0.518)
North West	1.031***	2.525***	0.630	1.026***	1.537**	1.692***
	(0.307)	(0.796)	(0.586)	(0.321)	(0.729)	(0.422)
Yorkshire & Humber	0.563*	1.130	0.791	1.036***	1.096	1.709***
	(0.326)	(0.844)	(0.620)	(0.345)	(0.779)	(0.455)
East Midlands	0.970***	1.537*	2.961***	0.252	-1.883**	0.493
	(0.329)	(0.851)	(0.622)	(0.349)	(0.790)	(0.458)
West Midlands	1.008***	2.510***	2.062***	0.949***	1.518*	1.222***
	(0.323)	(0.838)	(0.609)	(0.347)	(0.788)	(0.457)
East of England	0.824***	2.234***	3.551***	0.267	0.133	1.068**
	(0.317)	(0.820)	(0.600)	(0.336)	(0.761)	(0.442)
South East	0.709**	2.388***	2.085***	-0.063	-0.377	0.188
	(0.296)	(0.763)	(0.559)	(0.312)	(0.707)	(0.409)
South West	0.100	0.832	2.257***	-0.307	-0.270	-0.131
	(0.319)	(0.824)	(0.608)	(0.336)	(0.760)	(0.443)
Wales	1.164**	2.987**	3.824***	1.082**	1.830	1.618**
	(0.496)	(1.275)	(0.924)	(0.518)	(1.169)	(0.670)
Scotland	0.927**	0.880	2.151***	1.377***	2.170**	2.505***
	(0.402)	(1.036)	(0.752)	(0.422)	(0.959)	(0.550)
Saver	-0.560***	-1.769***	-0.916***	-1.062***	-2.886***	-1.148***
	(0.139)	(0.360)	(0.264)	(0.150)	(0.338)	(0.197)
Constant	16.939***	63.297***	5.716***	20.153***	68.390***	22.738***
	(0.652)	(1.691)	(1.244)	(0.711)	(1.603)	(0.945)
Observations	5,035	5,082	4,738	6,763	6,825	6,509
R-squared	0.094	0.175	0.089	0.052	0.093	0.102

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. For definition of the variables see Table 1.

Table 3: *Partial effects on relationship between savings and body fatness*

	Men			Women		
	(1M)	(2M)	(3M)	(1W)	(2W)	(3W)
VARIABLES	BMI	WC	PBF	BMI	WC	PBF
Age	0.385***	1.248***	0.674***	0.366***	0.881***	0.501***
	(0.040)	(0.103)	(0.077)	(0.046)	(0.103)	(0.061)
Age squared	-0.004***	-0.011***	-0.006***	-0.004***	-0.007***	-0.004***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Married	0.557***	1.279**	0.468	0.058	0.057	0.308
	(0.193)	(0.502)	(0.371)	(0.225)	(0.508)	(0.300)
Divorced/separated	0.204	0.369	0.029	-0.017	0.339	0.329
	(0.279)	(0.724)	(0.537)	(0.281)	(0.631)	(0.373)
Degree	-0.661***	-2.192***	-1.315***	-1.499***	-3.739***	-1.591***
	(0.231)	(0.601)	(0.447)	(0.267)	(0.601)	(0.356)
A-level	0.294	0.073	-0.364	-0.697**	-2.470***	-0.348
	(0.244)	(0.634)	(0.472)	(0.290)	(0.654)	(0.387)
GCSE	0.311	0.703	-0.324	-0.518*	-1.260**	-0.129
	(0.248)	(0.644)	(0.481)	(0.269)	(0.606)	(0.360)
Employed	0.161	-0.023	-0.447	-0.337*	-1.091**	-0.418
	(0.216)	(0.558)	(0.420)	(0.194)	(0.438)	(0.258)
Unemployed	-0.264	0.072	0.570	-0.840**	-1.115	-0.600
	(0.329)	(0.849)	(0.634)	(0.396)	(0.892)	(0.531)
Children under 16	0.666	1.251	-0.051	-0.094	0.003	-0.101
	(0.411)	(1.072)	(0.788)	(0.099)	(0.224)	(0.132)
North East	0.678*	0.960	2.875***	0.981**	1.332	1.903***
	(0.389)	(1.006)	(0.753)	(0.410)	(0.925)	(0.549)
North West	0.848***	1.925**	0.438	0.888***	1.365*	1.488***
	(0.318)	(0.826)	(0.615)	(0.335)	(0.756)	(0.444)
Yorkshire & Humber	0.411	0.443	0.432	0.907**	0.886	1.526***
	(0.337)	(0.878)	(0.655)	(0.361)	(0.813)	(0.481)
East Midlands	0.686**	0.590	2.638***	0.146	-2.099**	0.298
	(0.342)	(0.891)	(0.658)	(0.365)	(0.823)	(0.483)
West Midlands	0.859**	1.845**	1.648**	0.796**	1.236	0.996**
	(0.334)	(0.869)	(0.640)	(0.364)	(0.821)	(0.482)
East of England	0.727**	1.961**	3.379***	0.257	0.213	0.981**
	(0.327)	(0.850)	(0.631)	(0.349)	(0.789)	(0.463)
South East	0.509*	1.741**	1.899***	-0.118	-0.254	0.091
	(0.305)	(0.791)	(0.587)	(0.325)	(0.734)	(0.430)
South West	0.005	0.281	1.849***	-0.508	-0.527	-0.378
	(0.329)	(0.855)	(0.638)	(0.353)	(0.795)	(0.469)
Wales	0.920*	2.021	3.456***	0.692	0.746	1.151
	(0.508)	(1.312)	(0.961)	(0.535)	(1.204)	(0.700)
Scotland	0.833**	0.460	1.967**	1.261***	1.929*	2.397***
	(0.410)	(1.060)	(0.780)	(0.435)	(0.984)	(0.573)
Log household income	-0.118	-0.209	-0.203	-0.454***	-0.978***	-0.286*
	(0.114)	(0.296)	(0.221)	(0.126)	(0.285)	(0.167)
Saver	-0.413***	-1.236***	-0.583**	-0.640***	-1.740***	-0.744***
	(0.151)	(0.392)	(0.290)	(0.165)	(0.372)	(0.219)
Constant	19.047***	67.011***	7.523***	24.426***	77.949***	25.610***
	(1.318)	(3.417)	(2.550)	(1.432)	(3.228)	(1.904)
Observations	4,639	4,680	4,374	6,144	6,199	5,924
R-squared	0.088	0.164	0.087	0.060	0.100	0.099

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. For definition of the variables see Table 1.

Table 4: *Interaction effects of education and savings on body fatness measures*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	BMI1	BMI2	BMI3	WC1	WC2	WC3	PBF1	PBF2	PBF3
MEN									
degree	-0.623**	-0.673***	-0.636***	-2.127***	-2.237***	-2.125***	-0.942*	-1.346***	-1.197***
	(0.267)	(0.232)	(0.232)	(0.694)	(0.604)	(0.603)	(0.515)	(0.449)	(0.448)
alevel	0.288	0.375	0.307	0.064	0.376	0.109	-0.421		-0.302
	(0.245)	(0.282)	(0.244)	(0.636)	(0.733)	(0.634)	(0.474)		(0.472)
gcse	0.309	0.308	0.119	0.699	0.692		-0.348	-0.332	-1.245**
	(0.248)	(0.248)	(0.279)	(0.645)	(0.644)			(0.481)	(0.542)
saver	-0.377*	-0.364**	-0.522***	-1.176**	-1.054**	-1.534***	-0.237	-0.452	-1.101***
	(0.194)	(0.173)	(0.168)	(0.505)	(0.450)	(0.437)	(0.375)	(0.333)	(0.323)
1.degree1#1.saver	-0.086			-0.145			-0.826		
	(0.295)			(0.766)			(0.567)		
1.alevel#1.saver		-0.194			-0.721			-0.523	
		(0.336)			(0.872)			(0.648)	
1.gcse#1.saver			0.534			1.451			2.543***
			(0.359)			(0.933)			(0.693)
Observations	4,639	4,639	4,639	4,680	4,680	4,680	4,374	4,374	4,374
R-squared	0.088	0.088	0.088	0.164	0.165	0.165	0.087	0.087	0.090
Women									
degree	-1.664***	-1.547***	-1.510***	-4.235***	-3.834***	-3.776***	-1.612***	-1.618***	-1.596***
	(0.296)	(0.268)	(0.268)	(0.667)	(0.603)	(0.602)	(0.394)	(0.357)	(0.357)
alevel	-0.663**	-0.383	-0.703**	-2.368***	-1.828**	-2.488***	-0.343	-0.162	-0.350
	(0.291)	(0.328)	(0.290)	(0.656)	(0.738)	(0.654)	(0.388)	(0.436)	(0.387)
gcse	-0.497*	-0.537**	-0.452	-1.198**	-1.298**	-1.036	-0.126	-0.140	-0.098
	(0.270)	(0.269)	(0.297)	(0.607)	(0.606)	(0.670)	(0.361)	(0.360)	(0.398)
saver	-0.821***	-0.475***	-0.593***	-2.279***	-1.403***	-1.581***	-0.767***	-0.646***	-0.723***
	(0.217)	(0.183)	(0.188)	(0.488)	(0.413)	(0.424)	(0.289)	(0.244)	(0.250)
1.degree1#1.saver	0.412			1.230*			0.052		
	(0.321)			(0.722)			(0.425)		
1.alevel#1.saver		-0.806**			-1.650*			-0.478	
		(0.392)			(0.884)			(0.521)	
1.gcse#1.saver			-0.192			-0.646			-0.089
			(0.368)			(0.829)			(0.491)
Observations	6,144	6,144	6,144	6,199	6,199	6,199	5,924	5,924	5,924
R-squared	0.060	0.061	0.060	0.100	0.100	0.100	0.099	0.099	0.099

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The interaction terms 1.degree##saver indicate that degree==1 and saver==1. The same pattern holds for the other interaction terms. For definition of the other variables see Table 1.